Ch 16/17 Prac MC

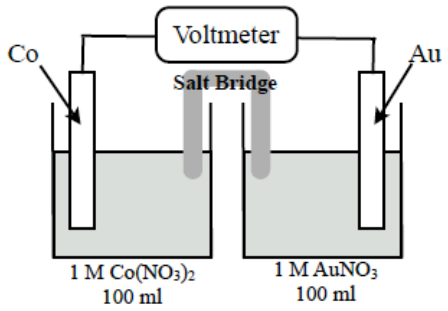
No Calculators and only your periodic table.
Give yourself the practice you deserve by timing yourself for 32 min

Questions 1 - 9 refer to the following electrochemical cell.

The spontaneous reaction that occurs when the cell below operates at 25ºC is:

$$2Au^{+1} + Co_{(s)} \rightarrow 2Au_{(s)} + Co^{+2}$$

(A) Voltage increases
(B) Voltage decreases
(C) Voltage becomes zero and remains at zero.
(D) No change in voltage occurs.
(E) Direction of voltage change cannot be predicted without additional information.



Which of the above occurs for each of the following circumstances?

1. The salt bridge is removed.
2. The salt bridge is replaced with a platinum wire.
3. 100 ml of distilled water is added to both compartments.
4. Current is allowed to flow for 20 minutes.
5. Half of the $AuNO_3$ solution is removed and is replaced with the same volume of distilled water.
6. 50.0 g of solid $Au(NO_3)_2$ is added to the right beaker. (Assume no volume increase.)
7. The gold electrode is replaced with a platinum electrode
8. 20 ml of 1 M Na_2CrO_4 is added to the both beakers.
9. The Co electrode is made twice as large.

Directions: Each of the following questions or incomplete statements below is followed by five suggested answers or completions. Select the one that is best in each case and then circle the answer on the answer sheet.

10. $Ni_{(s)} + 2Cu^{+1} \rightarrow Ni^{+2} + 2Cu_{(s)}$

If the equilibrium constant for the reaction above is greater than 1, which of the following correctly describes the standard voltage, Eº, and the standard free energy change, ΔGº, for this reaction?

a. Eº and ΔGº are both positive
b. Eº and ΔGº are both negative
c. Eº and ΔGº are both zero
d. Eº is positive and ΔGº is negative
e. Eº is negative and ΔGº is positive

11. Which of the following must be true for a reaction that proceeds spontaneously from initial standard state conditions?

a. ΔGº is positive and K_{eq} is greater than 1
b. ΔGº is positive and K_{eq} is less than 1
c. ΔGº is negative and K_{eq} is greater than 1
d. ΔGº is negative and K_{eq} is less than 1
e. ΔGº is equal to 0 and K_{eq} is equal to 1

Questions 12-13 refer to an electrolytic cell that involves the following half-reaction.

$$AuCl_4^- + 3e^- \rightarrow Au + 4Cl^-$$

12. Which of the following occurs in the reaction?
    a. Au is oxidized at the anode.
    b. $AuCl_4^-$ is the oxidizing agent.
    c. Gold is converted from the -3 oxidation state to the 0 oxidation state
    d. Cl^- acts as a reducing agent.
    e. Cl^- is oxidized at the anode.

13. A steady current of 2.0 amperes is passed through a gold production cell for 10 minutes. Which of the following is the correct expression for calculating the number of grams of gold produced?
(1 faraday = 96,500 coulombs)

    a. $\frac{(10)(2)(60)}{(96{,}500)(3)(197)}$ g

    b. $\frac{(10)(2)(96{,}500)}{(197)(60)}$ g

    c. $\frac{(3)(197)}{(96{,}500)(10)(2)(60)}$ g

    d. $\frac{(96{,}500)(197)}{(10)(2)(60)(3)}$ g

    e. $\frac{(10)(2)(197)(60)}{(96{,}500)(3)}$ g

$$Zn + Cu^{+2} \rightarrow Cu + Zn^{+2}$$

14. An electrolytic cell based on the reaction represented above was constructed from zinc and copper half-cells. The observed voltage was found to be 1.20 volts instead of the standard cell potential, E°, of 1.10 volts. Which of the following could correctly account for this observation?
    a. The zinc electrode contained more mass than the copper electrode.
    b. The Zn^{2+} electrolyte was 0.5 M $Zn(NO_3)_2$, whereas the Cu^{2+} electrolyte was 1.0 M $Cu(NO_3)_2$.
    c. The Zn^{2+} solution was colorless, whereas the Cu^{2+} solution was blue.
    d. The solutions in the half-cells began at different temperatures.
    e. The salt bridge contained NaBr as the electrolyte.

15. $2\ Fe^{+2} + Cu^{+2} \rightarrow 2\ Fe^{+3} + Cu_{(s)}$

If the equilibrium constant for the reaction above is 2.5×10^{-4}, which of the following correctly describes the standard voltage, E°, and the standard free energy change, $\Delta G°$, for this reaction?
    a. E° and $\Delta G°$ are both zero
    b. E° and $\Delta G°$ are both positive
    c. E° and $\Delta G°$ are both negative
    d. E° is positive and $\Delta G°$ is negative
    e. E° is negative and $\Delta G°$ is positive

16. For which of the following processes would ΔS have a positive value?
    I. $MgCO_{3(s)} \rightarrow MgO_{(s)} + CO_{2(g)}$
    II. $Ba^{2+} + SO_4^{2-} \rightarrow BaSO_{4(s)}$
    III. $Cl_{2(g)} + C_3H_{6(g)} \rightarrow C_3H_6Cl_{2(g)}$
    a. I only
    b. I and II only
    c. I and III only
    d. II and III only
    e. I, II, and III

$$SF_{4(g)} + F_{2(g)} \rightarrow SF_{6(g)}$$

17. The reaction above is thermodynamically spontaneous at 298, but becomes non spontaneous at higher temperatures. Which of the following is true at 298 K?
    a. ΔG, ΔH, and ΔS are all positive
    b. ΔG, ΔH, and ΔS are all negative
    c. ΔG and ΔH are negative, but ΔS is positive
    d. ΔG and ΔS are negative, but ΔH is positive
    e. ΔG and ΔH are positive, but ΔS is negative

18. In the electroplating of chromium, 0.40 faraday of electrical charge is passed through a solution of $CrSO_4$. What mass of chromium is deposited?
(1 faraday = 96,500 coulombs)
    a. 5.2 g
    b. 2.6 g
    c. 10.4 g
    d. 20.8 g
    e. 130 g

19. Which of the following expressions is correct for the maximum mass of zinc, in grams, that could be plated out by electrolyzing aqueous $ZnCl_2$ for 10 hours at a constant current of 2.0 amperes?
(1 faraday = 96,500 coulombs)

a. $\dfrac{(60)(10)(65)}{(96{,}500)(2)}$ g

b. $\dfrac{(10)(60)(60)(65)(2)}{(96{,}500)(2)}$ g

c. $\dfrac{(65)(96{,}500)}{(2)(10)(60)(60)}$ g

d. $\dfrac{(10)(60)(60)}{(96{,}500)(2)(65)}$ g

e. $\dfrac{(2)(60)(60)(65)}{(96{,}500)(10)}$ g

$$Zn + Cu^{+2} \rightarrow Cu + Zn^{+2}$$

20. Which of the following reactions has the largest positive value of ΔS?

a. $2\ H_2S_{(g)} + SO_{2(g)} \rightarrow\ 3\ S_{(s)} + 2\ H_2O_{(g)}$

b. $2\ SO_{3(g)} \rightarrow\ 2\ SO_{2(g)} +\ O_{2(g)}$

c. $Mg_{(s)} +\ Cl_{2(g)} \rightarrow MgCl_{2(s)}$

d. $Fe_2O_{3(s)} +\ 3\ H_{2(g)} \rightarrow\ 2\ Fe_{(s)} + 3\ H_2O_{(g)}$

e. $H_{2(g)} +\ ½O_{2(g)} \rightarrow\ H_2O_{(L)}$

21. Consider the reactions below to answer the question.

$2C_6H_{6(L)} + 15O_{2(g)} \rightarrow 12CO_{2(g)} + 6H_2O_{(L)}\ \ \Delta G^o = -6400$ kJ

$C_{(s)} +\ O_{2(g)} \rightarrow CO_{2(s)}\ \Delta G^o = -400$ kJ

$H_{2(g)} +\ ½O_{2(g)} \rightarrow\ H_2O_{(L)}\ \ \Delta G^o = -250$ kJ

What is the standard free energy change for the reaction below, as calculated from the data above?

$$6\ C_{(s)}\ +\ 3\ H_{2(g)}\ \rightarrow C_6H_{6(L)}$$

a. −250 kJ

b. −100.0 kJ

c. −50.0 kJ

d. 50.0 kJ

e. 100.0 kJ

22. If a copper sample containing some zinc impurity is to be purified by electrolysis, the anode and the cathode must be which of the following?

	Anode	Cathode
a.	Pure copper	Pure zinc
b.	Pure zinc	Pure copper
c.	Pure copper	Impure copper sample
d.	Impure copper sample	Pure copper
e.	Impure copper sample	Pure zinc

23. For which process is Δ*S* negative?

a. evaporation of 1 mol of $CCl_4(l)$
b. mixing 5 mL ethanol with 25 mL water
c. compressing 1 mol Ne at constant temperature from 0.5 atm to 1.5 atm
d. raising the temperature of 100 g Cu from 275 K to 295 K
e. grinding a large crystal of KCl to powder

24. For the reaction $A(g) \leftrightarrows B(g) + C(g)$, the equilibrium constant, K_p, is 2.0×10^{-4} at 25°C. A mixture of the three gases at 25°C is placed in a reaction flask and the initial pressures are $P_A = 2$ atm, $P_B = 0.5$ atm, and $P_C = 1$ atm. At the instant of mixing, which of the following is true for the reaction as written?

a. $\Delta G < 0$
b. $\Delta G > 0$
c. $\Delta S = 0$
d. $\Delta G^o = 0$
e. $\Delta G^o < 0$

$$N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$$

25. The reaction indicated above is thermodynamically spontaneous at 298 K, but becomes nonspontaneous at higher temperatures. Which of the following is true at 298 K?

a. Δ*G*, Δ*H*, and Δ*S* are all positive.
b. Δ*G*, Δ*H*, and Δ*S* are all negative.
c. Δ*G* and Δ*H* are negative, but Δ*S* is positive.
d. Δ*G* and Δ*S* are negative, but Δ*H* is positive.
e. Δ*G* and Δ*H* are positive, but Δ*S* is negative.

Answer Key

1	c	**14**	b
2	c	**15**	e
3	b	**16**	a
4	b	**17**	b
5	b	**18**	c
6	a	**19**	b
7	d	**20**	b
8	b	**21**	d
9	d	**22**	e
10	d	**23**	c
11	c	**24**	b
12	b	**25**	b
13	e		